iRZ®
automation

TC65Smart

Contents

1.General Information.

1.1.   Purpose of the Device

The terminal TC65Smart is an industrial quad-band GSM modem with batch transmission support GPRS Multislot Class 12. The terminal was developed based on the honeycomb module Siemens TC65, and it can be easily integrated into any application due to the Java open platform support and the embedded TCP/IP suit. The TC65Smart is used as an effective solution in different areas:

- vending machine control and driving systems
- observation and access control systems
- navigation and logistics systems
- long-distance measurement and TV services

The TC65Smart has four digital inputs, two analog inputs, interface i2c. All the inputs and outputs are galvanically isolated from the control module Siemens TC65.

The terminal includes the ability of voice communication, high-speed wireless data transfer, reception and transferring of short messages and telecopies.

The terminal is equipped with the GPRS support Class 12, standard industrial interfaces and Java platform for software development to create proprietary M2M applications. Herewith starting and control of the applications is possible directly through the microprocessor Siemens TC65 Terminal.

Due to the embedded TCP/IP suit, the data, e.g. sensor readings, can be transferred from the terminal to the server via the Internet, the security of the transmission medium is provided by the use of HTTPS and PKI cryptooperation.

Most important functional capabilities of the Siemens TC65 Terminal:

1. Support of four GSM ranges: EGSM 900 and GSM 850/1800/1900
2. Open platform for development of Java applications
3. Embedded microprocessor and TCP/IP suit
4. Support of the package transmission mode GPRS Multislot Class 12
5. Support of the channel for control of the batch broadcasting (PBCCH)
6. Standard interfaces:
    6.1. RS-232 (DB-9 8 signals);
    6.2. RS485 (RJ-9);
    6.3. Votronik Handset (RJ-9)
7. Set of tools for SIM applications
8. Superset of AT commands for industrial applications

1.2.   Parameters

General Parameters

- Radio frequency ranges: GSM 850 / 900 / 1800 / 1900
- GSM Release 99
- Consistency with GSM Phase 2/2+
- Power output:

Class 4 (2 Вт) for EGSM850/900
Class 1 (1 Вт) for GSM1800/1900

- Control of AT comands Hayes GSM 07.05 and GSM 07.07
- Support of SIM Applicaion Toolkit release 99
- Power supply voltage: 9...30 V
- Size: 110 x 76 x 30 mm
- Weight: 190 g
- Operating-temperature range: -20...+50 °C
- Automatic power-off at temperature more than +75 °C
- Storage temperature: -40...+85 °C

Open software platform parameters

- Processor ARM7
- Memory: 400 Kb (RAM), 1.7 Mb (Flash)
- Economy power supply mode
- Control of TCP/IP suits through AT commands

Transmission of data, SMS and telecopies

- GPRS Class B Multislot Class 12
- SMS reception and transmission:
    - Transmission via GSM and GPRS
    - Peer-to-Peer MO and MT
    - Broadband transmission
    - Text mode, PDU mode
- Fax Group 3, Class 1
- Full support PBCCH
- CSD (up to 14.4 kbit/s)
- USSD
- Nontransparent mode
- V.110
- Coding scheme CS 1, 2, 3, 4

Java ™ parameters

- CLDC 1.1 Hl
- J2ME™ with support IMP 2.0
- Protected data transmission with HTTPS and PKI support
- Support of TCP, UDP, HTTP, FTP, SMTP, POP3
- Remote upgrade of applications (OTAP)

Voice communication

- Voice encoding HR/FR/EFR/AMR
- Basic hands-free operations
- Noise abatement and echo cancellation functions

Interfaces

- Audio interface RJ-9 for hand receiver connection;
- Two SIM card readers;
- Connector for SMA antenna connection;
- 8-pin serial interface RS-232 (DB-9 DCE V.250);
- Additional serial interface RS-485 (RJ-11) for connection of additional devices (depending on modification, it can be supplied with a two-wire RS-232 or LVUART);
- 16-pin Connector Eurostyle™ Horizontal PCB Header: I2C bus line, 2 analog inputs (AD converter), 4xGPI, 4xGPO ;
- Status visual indicator;
- Visual indicators of the operated SIM card;
- Debugging visual indicator.

1.3. Exterior Appearance of the Device

The housing of the device is made of metal, the control elements are put out to the front and back panels of the device. The exterior appearance of the device is represented on Fig. 1.1 and Fig. 1.2.

Fig.1.1 Front view

Fig.1.2 Back view

1.4.   External Connectors and Indication Elements.
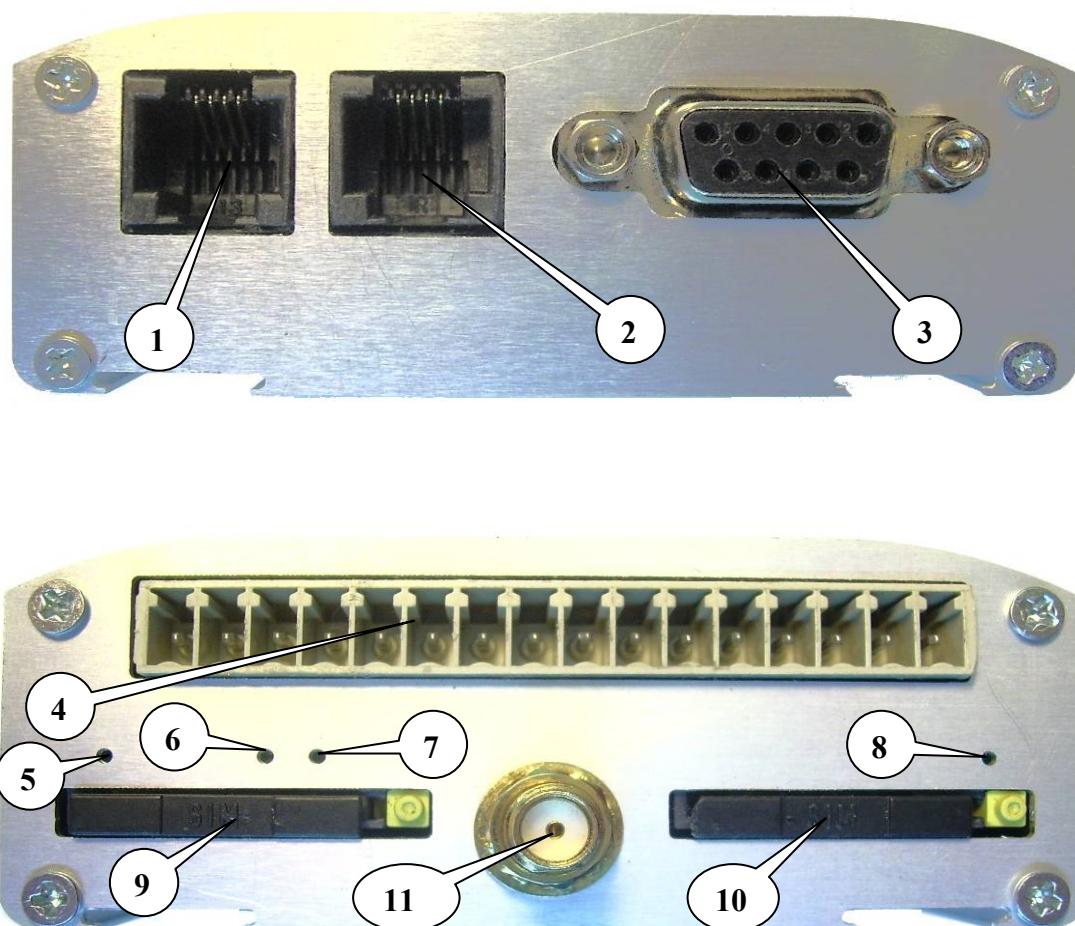
Fig. 1.3 Connectors and indication elements

On the figure the digits signify the following:
1. Connector for computer headset connection. (see Section 2.3)
2. Connector for connection of a cable to the second (additional) serial port у RS-485 (RS-232, LVUART). (see Section 2.2)
3. Connector for connection of the first (basic) RS-232. (see Section 2.1)
4. Terminal I/O connector. (see Section 2.4.)
5. Visual indicator for operation of the first SIM card. (see Section 3.2)
6. Debugging visual indicator. (see Section 3.4)
7. Visual connection status indicator. (see Section 3.4)
8. Visual indicator for operation of the second SIM card. (see Section 3.2)
9. First SIM card tray. (see Section 3.2)
10. Second SIM card tray. (see Section 3.2)
11. SMA connector for antenna connection.

1.5.   Functional Diagram.
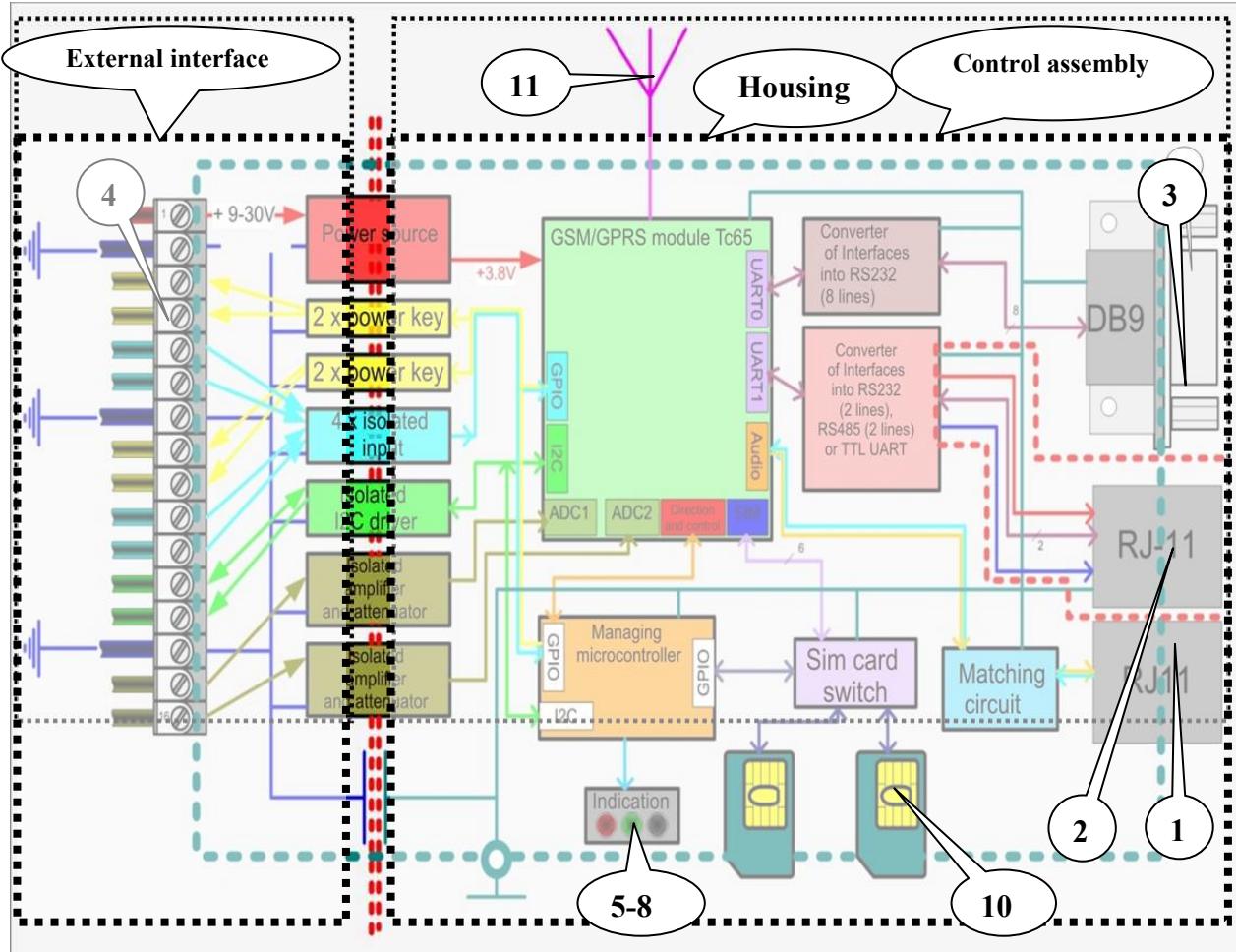
Fig. 1.4

Fig. 1.4 represents the functional diagram of the terminal TC65Smart. The digits signify the external connectors and indication elements. Numbering is the same as in Clause 1.4 and Fig. 1.3.

As it is electrically shown in Fig. 1.4, the Terminal is divided into two galvanically isolated parts:

Control assembly, including:
- GSM module Siemens TC65;
- Control assembly for two SIM cards;
- PC-consistent, eight-wire interface RS-232 (connector DB-9F) with the control level conversion circuit;
- Two-wire interface UART (connector RJ-11), capable of performing the following functions, depending on the Terminal modification:
    o Interface RS-485,
    o Interface RS-232 (RX/TX),

o Interface LVUART (UART with TTL/CMOS-consistent signal levels).
- Backup drive controller;
- Indication mechanisms;
- Headset adapter circuit.

External interface:
- 4 lines of digital current inputs;
- 4 lines of powerful control switches (for the current up to 1A), which can commutate the load both for "+" of the energy supply and for the common wire. The switches configuration depends upon the modification of the item. Such version can be supplied:
  o 4 switches for "+";
  o 4 switches for the "common" wire;
  o 2 switches for "+", 2 switches for the "common" wire.
- 2 analog voltage measuring inputs (ADC0,ADC1). The range of the measured voltages (-250mV)-(+24250mB), accuracy +/- 100mV;
- Bus-line I2C master. (for connection of several I2C Slave devices to the Terminal);
- Input for connection of the DC energy supply 9-30V.

Attention!
The metallic housing of the device is connected to the common wire of the control assembly. The common wire of the coaxial antenna connector is also connected to the housing. The energy supply and interface circuits are connected to the galvanically isolated common wire of the discontinuous terminal connector. Power supply can be fed only relating to the terminals "-". If the common wire of the energy supply turns to be connected with the Terminal housing, the system will save its operability, but all the advantages of the galvanic isolation will fail.

2. Connection of the Device to the Target System.
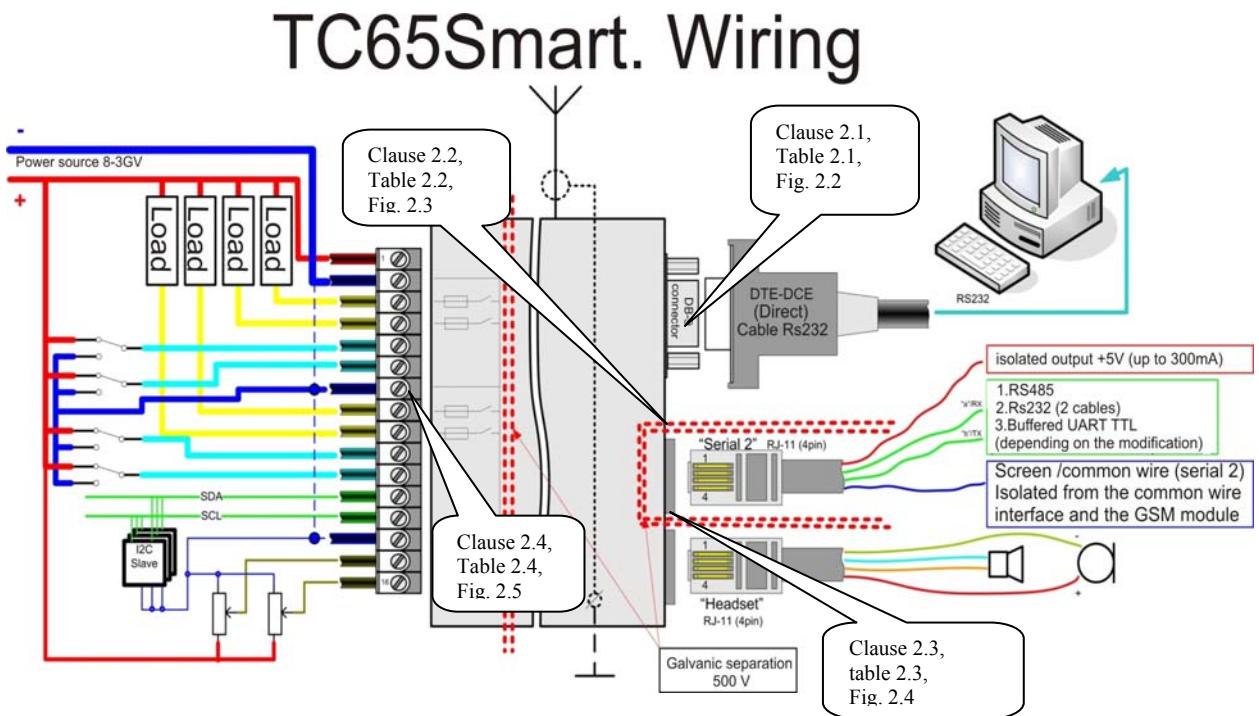
Fig. 2.1

2.1. Connector DB-9F for Connection to RS-232.

The connector is designed for connection to RS232 by the circuit DTE-DCE (by "DC" cable). It is connected via the adapter circuit to the inputs ASC0 of the module TC65. It can be connected to the computer for:

- Control of the Terminal through the AT commands;
- Loading and debugging of the control program;
- Exchange of information with the control program;
- Transmission of the GPRS/CSD traffic.

The signals are not isolated from the common wire of the GSM module and Terminal housing.
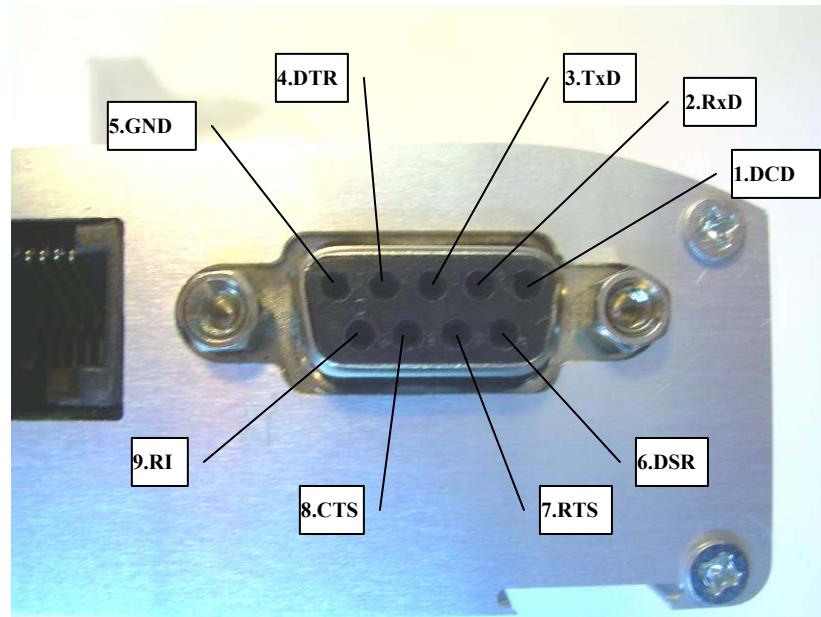
Рис. 2.2

Table 2.1

Contact	Signal	Direction	Level
1	DCD	Term. -> PC	> +/- 6V
2	RxD	Term. -> PC	> +/- 6V
3	TxD	PC -> Term.	> +/- 3V
4	DTR	PC -> Term.	> +/- 3V
5	GND	Common for the control assembly (housing)	> +/- 3V
6	DSR	Term. -> PC	> +/- 6V
7	RTS	PC -> Term.	> +/- 3V
8	CTS	Term. -> PC	> +/- 6V
9	RI	Term. -> PC	> +/- 6V

2.2. Connector RJ-11 for Connection of the Two-Wire UART.

It is used for connection of the accessories to ASC1 TC65. **The signals are not isolated from the common wire of the GSM module and Terminal housing.**
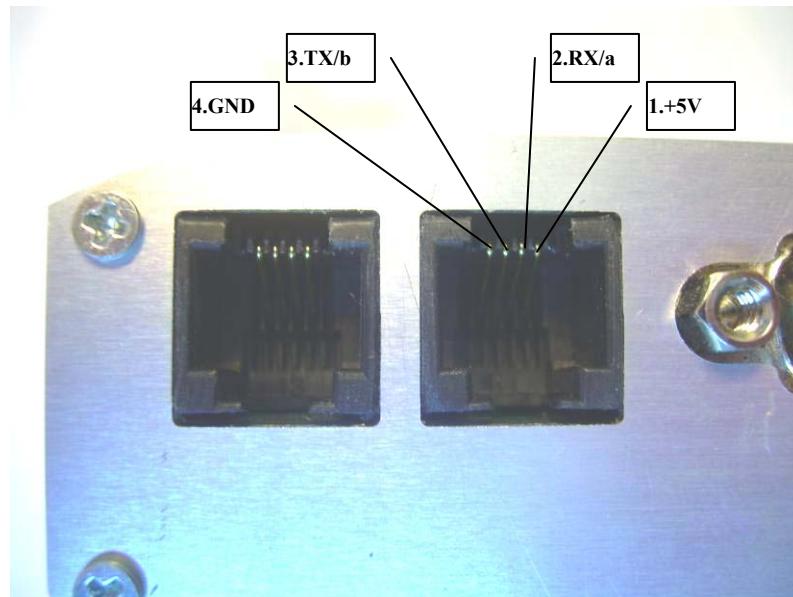
Fig. 2.3

Table 2.2

Cont.	Interface	Signal	Direction	Purpose
1	+5V (DC @<200mA)		Term. -> Accessories	Power supply of the accessories
2	RS485	"a" (D+)	<-> different.	Input/output RS485 not inverted
	RS232	RxD	Term. -> Accessories	Transmitter output RS232 (>+/-6V)
	LVUART	Rx	Term. -> Accessories	Transmitter output LVUART (TTL 3.3V)
3	RS485	"b" (D-)	<-> different.	Input/output RS485 inverted
	RS232	TxD	Accessories -> Term.	Receiver input RS232 (>+/-3V)
	LVUART	Tx	Accessories -> Term.	Receiver input LVUART (TTL 3.3V)
4	Common for the control assembly (housing)			Common wire

2.3.   Connector RJ-11 for Headset Connection.

It is designed for connection of the phone receiver or a headset which can be used for voice calls. The signals are not isolated from the common wire of the GSM module and the Terminal housing.
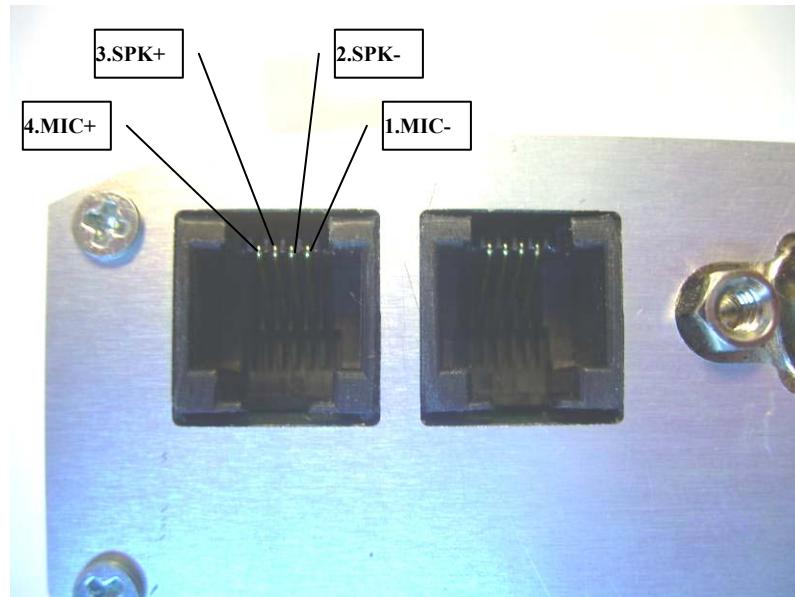
Fig. 2.4

The headset is connected to the first analog channel TC65 (enabled on default). The differential connection method is used. The microphone is powered through the line MIC+.

Table 2.3

Contact	Signal	Purpose
1	MIC-	Microphone input inverted
2	SPK-	Phones output inverted
3	SPK+	Phones output not inverted
4	MIC+	Microphone input and microphone powering not inverted (DC)

2.4. Discontinuous Terminal Connector.

The Terminal is powered and it exchanges the information with the external devices through this connector. All the electric circuits which are available on the connector (including power supply and the common wire) are galvanically isolated from the common wire of the GSM module and the Terminal housing.
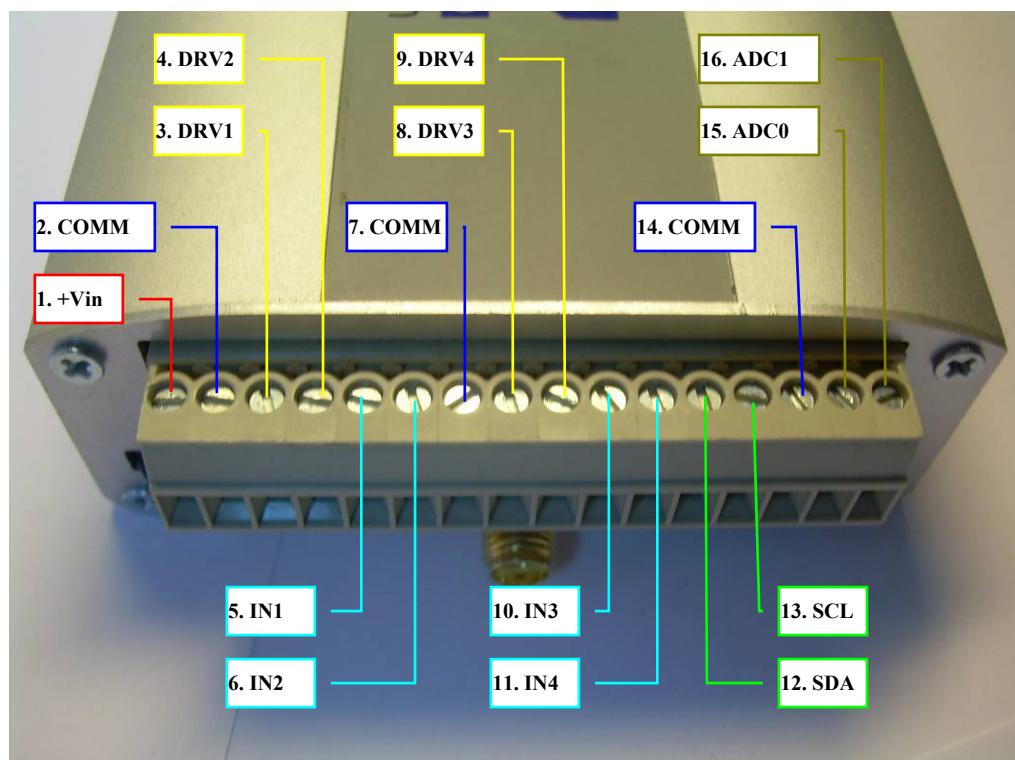

Fig. 2.5

Table 2.4

| Termi nal	Signal	Type	Corresponding signal of the module TC65 (numbers of the connector contacts are in brackets)	Maximum values of the signals	Note
1	+Vin	Input	-	+9 - +30V @ 600mA	Energy supply
2, 7, 14	COMM	-	-	Common	Common wire of the interface
3, 4	DRV1,DRV2	Output	GPIO1 (#71), GPIO2 (#72)	-1V - +Vin @ 0-1A, protection against inductive load currents	Outputs of power switches. (depending on the Terminal modification, they commutate either to COMM or to +Vin with supply of log. "1" respectively to the output GPIO TC65)
5,6	IN1,IN2	Input	GPIO7 (#8), GPIO8 (#6)	-3V - +30V, Current log. "1" > 2mA (turn-on voltage ~ 3V)	Current inputs. Without inversion they transmit log. signals to the corresponding inputs TC65
8,9	DRV3,DRV4	Output	GPIO3 (#73), GPIO4 (#74)	-1V - +Vin @ 0-1A, protection against inductive load currents	Outputs of power switches. (depending on the Terminal modification, they commutate either to COMM or to +Vin with supply of log. "1" respectively to the output GPIO TC65)
10,11	IN3,IN4	Input	GPIO9 (#76), GPIO10 (#5)	-3V - +30V, Current log. "1" > 2mA (turn-on voltage ~ 3V)	Current inputs. Without inversion they transmit log. signals to the corresponding inputs TC65
12,13	SDA,SCL	Input / Output, Output	I2CDAT(#70), I2CCLK(#11)	0-+5V, outputs with an open drain (standard is Philips I2C)	Bus-line I2C. The Terminal always operates in the Master mode (is always a timing reference source)
15,16	ADC0,ADC1	Analog input	ADC1(#2), ADC2(#3)	(-1V) – (+30V), Input resistance ~ 1.2MOhm	Potential inputs for voltage measuring. Measured voltage (> -500mV) – (< +24500mV). Voltages are transmitted to the inputs TC65 in the ratio 1:10 (the measured ADC TC65 voltage is 10 times lower than the actual voltage). The total measurement error does not exceed +/-100mV.
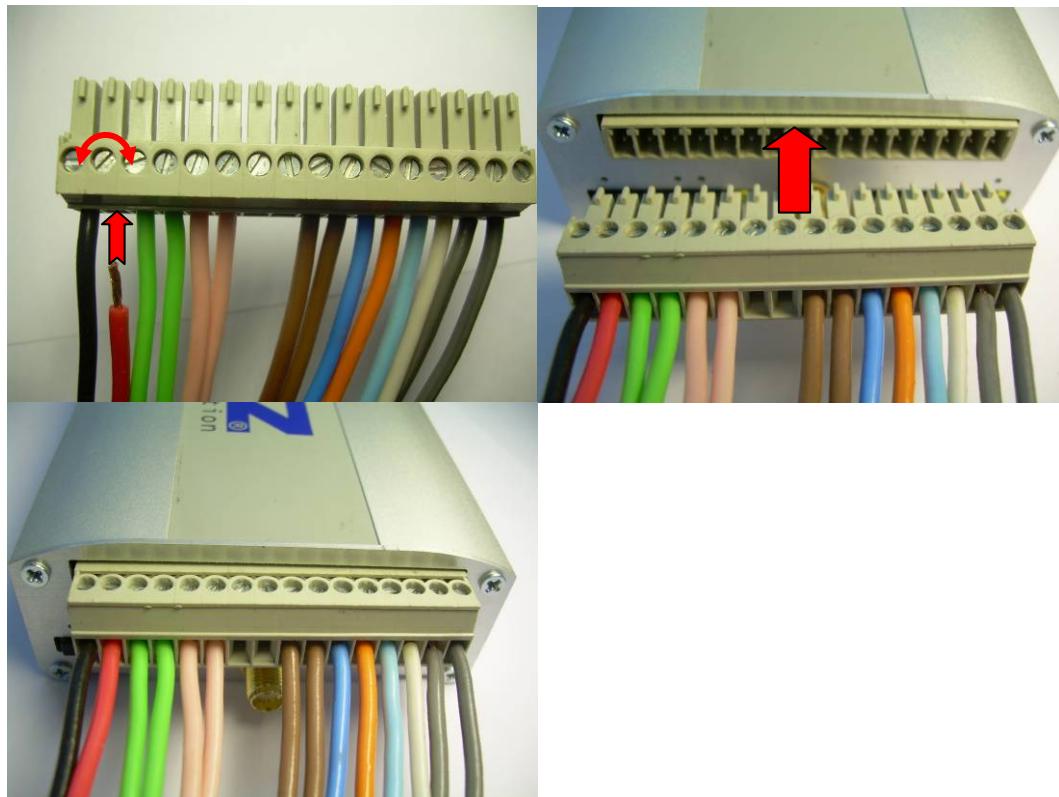
Fig. 2.5 Connection of the discontinuous terminal connector.

3.Operation of the Terminal Major Assemblies.

3.1.   Backup Controller.

It performs the following functions:
- Control of turning on and off of the GSM module TC65;
- Control of the SIM card switch;
- Indication control.
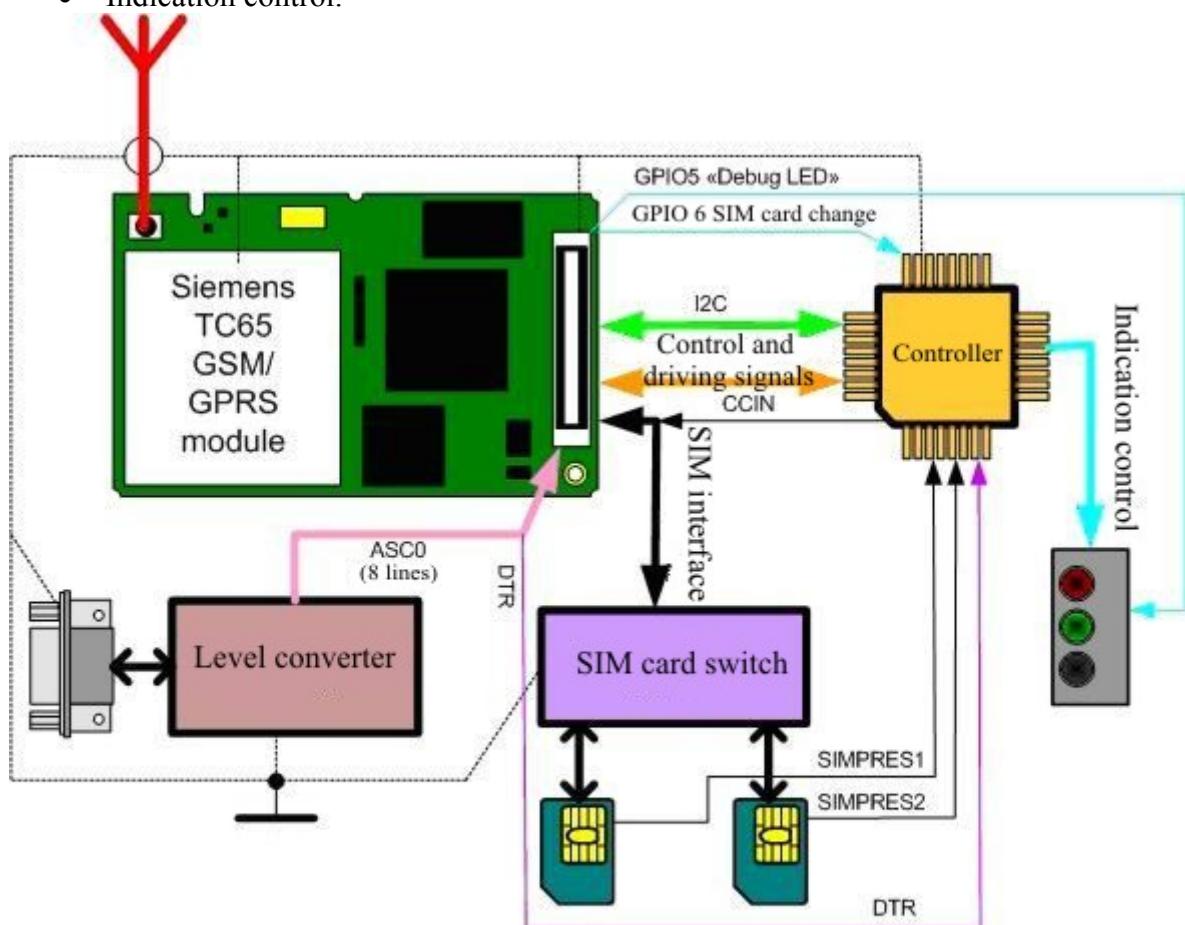
Fig. 3.1

As Fig. 3.1 shows, the backup controller receives the following signals:
- **Bus-line I2C with TC65 of the GSM module.**

On this bus line, in the quality of the Master device (synchronizing signal generator and bus line initiator) the GSM module always functions, which can transmit the control commands to the backup controller and receive the information on the system status. The controller is assigned a 7-bit address on the bus-line (the value is programmed by the user. On default – 0x7F). It makes it possible to use the bus line both for communication with the external devices through the interface connector (cont. 12,13 Fig. 2.5), and for communication with the embedded controller.

By means of I2C commands, the TC65 module is capable of:
- o Controlling the SIM card selection;
- o Controlling the power supply;
- o Changing the temporal and logic parameters for system operation;
- o Receiving the information on the system operation mode.

The full list of I2C commands is represented in Table 3.1. To transmit the commands to the controller from the TC65, it is required (either in the AT command mode or by Java command call):
- o To enter the I2C terminal – AT^SSPI=0000;
- o To issue the command in the format <XYYZZBB>, where
  - • "<" and ">" are mandatory characters signifying START and STOP of the bus line instance;
  - • X is any character of the Latin alphabet. It is not transmitted to the bus line, and it is designed only for indication of the current device for the TC65;
  - • YY is a hexadecimal number (0-9,A-F) determining the address of the device required on the bus-line:

YY7	YY6	YY5	YY4	YY3	YY2	YY1	YY0
Machine address of the required device (on default for the Controller – 0x7F)							0 – "recording" 1 – "reading"

- • ZZ is hexadecimal number (0-9,A-F) determining the code of the command for the controller;
- • BB is a hexadecimal number (0-9,A-F) determining the instruction operand for the controller (if the command requires it);

The input sequence of characters is not displayed on the screen. It is not transmitted on the bus line until the input of ">" character. After the transmission, the Terminal indicates the response o the slave device. If the transmission has been successful, the module indicates {X+} (X – indication, "+" – the character signifies "response is received");
- o To transmit the character "#", which completes the terminal operation.

- **The DTR signal from the interface level converter RS-232 («Serial1», ASC0 TC65).**
  This signal coming from the external device through the RS-232 is used by the Terminal to control the GSM module enabling and disabling. The terminal way of behavior depending on the DTR signal is programmed through the I2C command.

- **The GPIO6 signal from the TC65 module.**
  It is used by the controller as the SIM card switch alternative signal.

- **SIM card availability signals (SIMPRES1,2) directly from the mounts.**
  By these signals the controller determines the availability of the mounts during the SIM card change operations. Besides, during forced extraction of the active mount, the controller will automatically generate the card unavailability signal (CCIN) TC65 and attempts to switch the module to the other mount.

Table 3.1

Command	Byte code (HEX)	Operand byte	Action	Command I2C terminal TC65 (example)
TC65_reset	0x01	-	Causes hardware forced restarting of the TC65 module (the module initiates restarting, I2C terminal is disabled)	<aFE01>
TC65_off	0x02	-	Causes hardware blackout TC65 (the module is disabled, the communication of the module with the controller is interrupted. The module can be started only by the external DTR signal)	<aFE02>
TC65_onoff_io	0x03	0x00 or 0x01	The value 0x00 of the operand fully disables the external digital interface. The output drivers jump to the status "Off", and the inputs TC65 are disconnected from the terminal inputs (with any values on the outputs of the GPIO module). The value 0x01 enables the interface. After power-on of the terminal and starting of the GSM module, the interface is enabled automatically.	<aFE0300> / <aFE0301>
TC65_simpres	0x04	0x00 or 0x01	The value 0x01 of the operand transmits the SIM card deactivating signal to the GSM module. It causes forced disabling of the module from the GSM network and deactivation of the SIM interface. The value 0x00 of the operand transmits the SIM card availability signal to the module. The module starts the card reading operation and registration in the network.	<aFE0400> / <aFE0401>
TC65_DTR_ON	0x11	0x00-0xFF	The command sets up the starting mode of the disabled module by the DTR signal. The operand value determines the delay in x100ms (0-25.4s) since the time of the active DTR signal transmission (>+3V) until the automatic start of the module. The value 0xFF disabled the automatic start mode. The value 0x00 enables the automatic start at once after the signal transmission. The interval starts being counted since the appearance of the active DTR status (if the signal is not active, the controller will await its activation and start the timing). The value is saved in the non-volatile memory. The value on default is 3.2s. During the timing the indicator "PWR/STATE" flashes intermittently.	<aFE11xx>

TC65_DTR_OFF	0x12	0x00-0xFF	The command sets up the mode of hardware disabling of the enabled module by the DTR signal. The value of the operand determined the delay in x100ms (0-25.4c) since the time of removal of the active DTR signal. (< 0V) until the time of automatic disabling of the module. The value 0xFF disables the automatic disabling mode. The value 0x00 initiates the automatic disabling at once after the signal transmission. The value is saved in the non-volatile memory. The value on default is 0xFF (disabled). During the timing the indicator "PWR/STATE" flashes intermittently.	<aFE12xx>
SIM_change	0x40	0x00, 0x01	The command initiates the procedure for SIM card switching over. The operand determines the number of the required SIM mount (0 – the "SIM1" mount, 1 – the "SIM2" mount). The switching procedure goes along with the CCIN signal transmitted to the module, which makes it possible to disable the SIM interface at the switching moment, and the automatic start of registration in the network after the procedure is completed. If the SIM card "tray" is unavailable in the mount required by the command, the switching procedure is disabled. If the required mount is already active, the operator is repeatedly registered in the network. The selected value of the mount number is saved in the non-volatile memory of the controller. The last selected mount is automatically selected upon power-on. Selection of the mount is indicated by the corresp. indicators "SIM1" and "SIM2".	<aFE4000> / <aFE4001>
I2C_adr	0x70	0x00 – 0x7F	The command makes it possible to specify the Controller address on the bus-line I2C. On this address TC65 will address to the Controller. *It should not be forgotten that the address byte of the bus-line I2C contains the address in the higher 7 bits. The lower bit is used as a reading/recording marker.* If this command transmits the address 0x7F, the recording commands must be transmitted to the address 0xFE, the reading commands – to 0xFF (the instruction operand shifted to the left by 1 position). It is saved in the non-volatile memory. The initial value is 0x7F (0xFE-recording, 0xFF-reading). The controller jumps to the new address at once after the command is received.	<aFE7002> - switching over from the address 0x7F (0xFE/0xFF) to the address 0x02 (0x01/0x00)

## 3.2.   SIM Card Switch and SIM mounts.
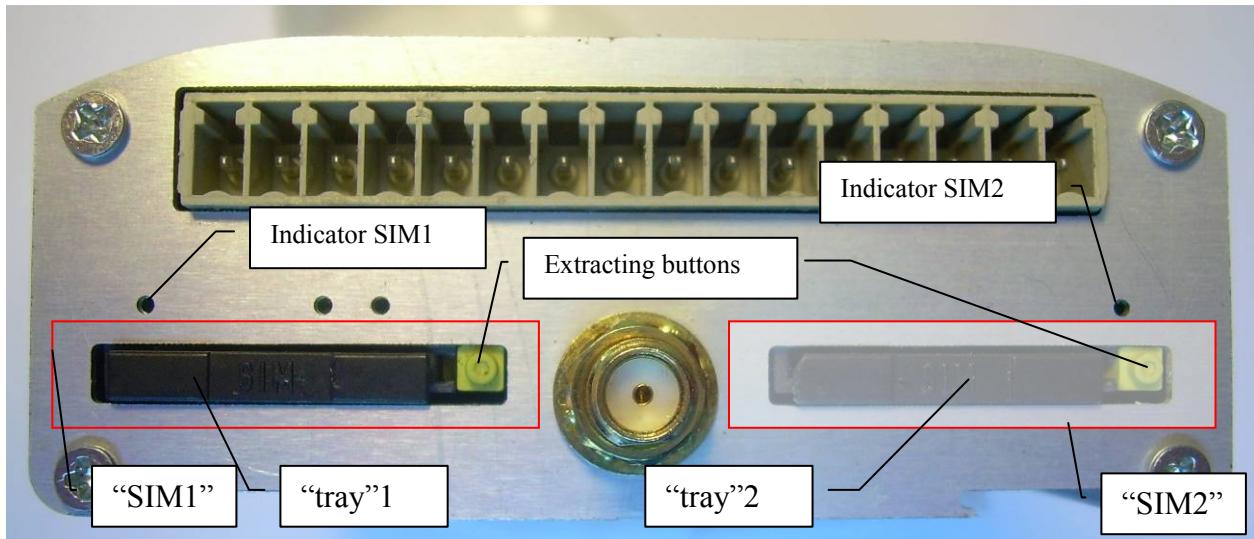
Fig. 3.2
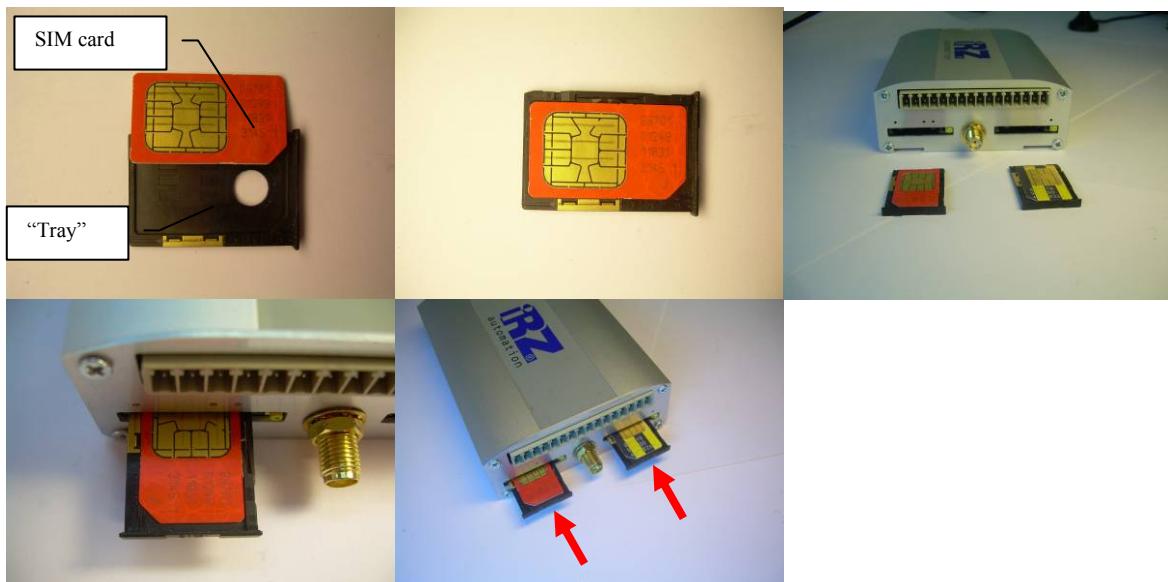
Fig. 3.3. SIM card installation into the terminal

To provide more capabilities for maintenance of GSM connection, the Terminal is equipped with two SIM-card mounts. Cards of different operators can be installed in these mounts. The Terminal controller provides switching of the mounts. The switching is made in three different ways:

3.2.1. By transmission of the command from TC65 through the bus-line I2C (see Table 3.1).

This way makes it possible to switch to the particular mount under the number (SIM1 or SIM2). After the switch, the registration in the network is started automatically. <u>The value of the current mount is recorded in the non-volatile memory and selected automatically during power-on.</u> If the "tray" has been extracted from the required mount, the switching procedure is disabled. (no actions performed);

3.2.2. By pulsing through the output TC65 GPIO6.

After transmitting of the combination log. "1" – log. "0" to the output GPIO6 (duration of retention of log. 1 - >50us), the Controller starts the SIM card changing procedure. If the current card has been SIM1, it will switch to SIM2 and vice versa. In other points, the switching procedure is completely analogous to Clause 5.2.1.

3.2.3. By mechanical extracting of the "tray" of the active SIM mount.

In this case, if the "tray" of the other mount is inserted, the mount changing operation will be started automatically, similarly with Clause 3.2.1

Important note:

SIM holders transmit into the system the information not about the installed SIM cards, but about the "trays" clicked up thereon. If an empty tray is clicked in the mount, the controller will anyway receive the information on the SIM card availability (see Fig. 11).

The indicators SIM1 and SIM2 flash depending on the selected mount. During the terminal operation, they flash repeating the signal on the SYNC output of the module TC65 (see the module documentation) inversely (SYNC="0" – indicator flashes and vice versa). In the SIM card change mode both indicators flash simultaneously. In the standby mode the SIM cards (no "tray" clicked) – indicators flash less frequently and in turn.

3.3. Power Supply Control of the Module TC65.

In addition to the regular methods of power supply control of the GSM module TC65 (power-off by the command AT^SMSO, emergency power-off , thermal shutdown etc.), the Terminal is equipped with some supplementary power supply control functions:

3.3.1. Automatic power-on upon voltage supply.
The module is automatically activated with supply voltage feeding. Exception is only the case where both SIM mount "trays" are not clicked while the power supply feeding. In this case the Controller will transmit the initiating command to the module after clicking of at least one "tray".

3.3.2. The module starting upon activation of the external DTR signal of the interface "Serial 1" (ASC0).
Enabling or disabling of this function, as well as the time of retention of the active DTR status before the start is defined by the Controller setting (I2C command TC65_DTR_ON see Table 5).

3.3.3. Disabling of the module upon deactivating of the external DTR signal of the interface "Serial 1" (ASC0).
Enabling or disabling of this function, as well as the time of retention of the passive DTR status before disconnecting is defined by the Controller setting (I2Ccommand TC65_DTR_OFF see Table 5).

3.3.4. Disabling of restarting of the module through transmission of I2C commands. (TC65_off and TC65_reset see Table 3.1).

3.4.   Indication Mechanisms.

The Terminal is equipped with 4 LED indicators for visual control of operation.
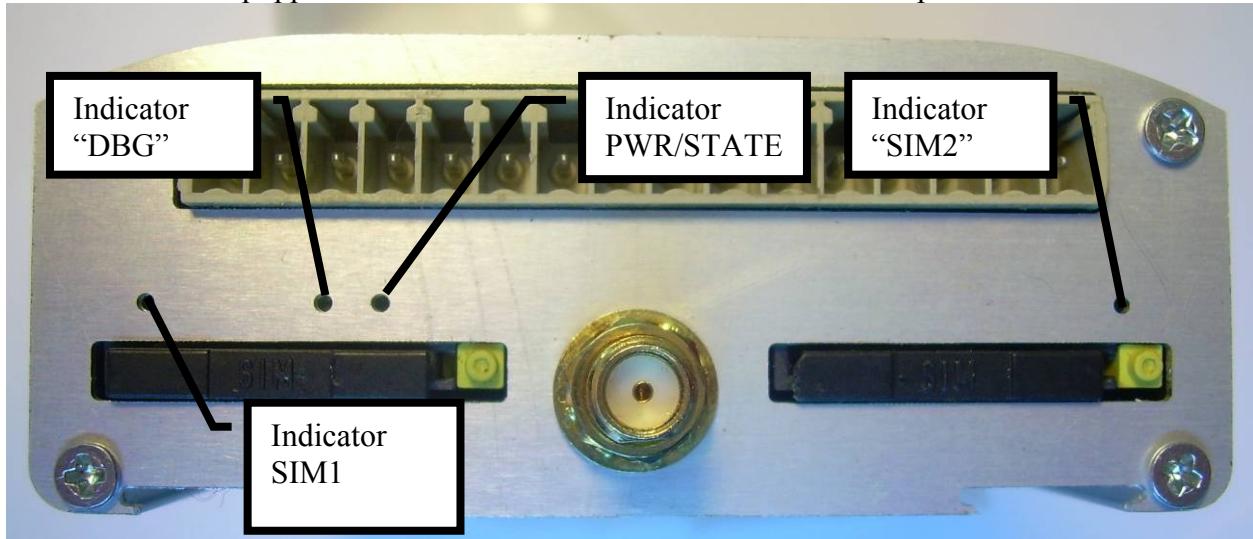
Fog. 12

- The operation of the indicators "SIM1" and "SIM2" has already been described in Clause 3.2.
- The indicator "DBG" is connected in the Terminal to the output GPIO5 of the module TC65. It flashes upon recording of log. "1" in GPIO5 by means of AT commands for GPIO control (or through JAVA) and can be applied by the user for choice.
- The indicator "PWR/STATE" is designed for the terminal status indication.
  - If it is not flashing – electric power supply is not fed;
  - If it is flashing continuously – the module is started and operates normally;
  - Frequent flashing – it determines that the Controller is enabling or disabling the module;
  - Rare flashing with predominant off-status - power is supplied, the module is disabled;
  - Rare flashing with predominant on-status – the terminal is conducting the DTR signal expectation for either enabling or disabling.

4.Supplementary Literature.

Whereas the terminal "TC65Smart" is based upon the GSM module Siemens TC65, supplementary documentation of the manufacturing company will be needed for operation:

- **TC65 AT Command Set** – guidelines on control of the module through the AT commands.

Supplementary literature is available for downloading on the site www.radiofid.ru in the section "Support of Products".